Pasadena Unified School District
BIOLOGY: 9 – 12TH
HS – LS1 From Molecules to Organisms: Structures and Processes

Stage 1: Desired Outcomes

Priority Standards

What Priority Next Generation Science Standards frame the learning objectives of this unit?

HS-LS1-1: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS1-4: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-6: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-7: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bond in new compounds are formed resulting in a net transfer of energy.

Supporting Standards

What supporting Next Generation Science Standards and Common Core Standards are important to the objectives of this unit?

Next Generation Science Standards

- **LS1A: Structure and Function**
  - Systems of specialized cells within organisms help them perform the essential functions o life.
  - All cells contain genetic information in the form of DNA molecules.
  - Multicellular organisms have a hierarchical structural organization, in which one system is made up of numerous parts and is itself a component of the next level.
  - Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external condition change within some range.
- **LS1B: Growth and Development**
  - In multicellular organisms, individual cells grow then divide via a process called mitosis, thereby allowing the organism to grow.

Common Core Standards

ELA/Literacy –

- **RST.11-12.1:** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- **WHST.9-12.2:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
- **WHST.9-12.5:** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is

most significant for a specific purpose audience.

- **WHST.9-12.7:** Conduct a short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- **WHST.9-12.8:** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.9-12.9:** Draw evidence from informational texts to support analysis, reflection, and research.
- **SL.11-12.5:** Make strategic use of digital media (i.e. textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Mathematics –

- **MP.4:** Model with mathematics.
- **HSF-IF.C.7:** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- **HSF-BF.A.1:** Write a function that describes a relationship between two quantities.

21st Century Skills

What 21st Century Skills will students be expected to demonstrate upon completion of this unit?

☒ *Learning & Innovation (4 C's)* ☒ *Information, Media & Technology*

☒ *Life & Career* ☒ *21st Century Themes*

Enduring Understandings *Big ideas at heart of the discipline; specific understandings desired about them.*	**Essential Questions** *What provocative questions will foster inquiry, understanding, and transfer of learning?*
• The structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. • The hierarchical organization of interacting systems that provide specific functions within multicellular organisms. • How feedback mechanisms maintain homeostasis. • How cellular division (mitosis) and differentiation in producing and maintaining complex organisms. • Cellular respiration and photosynthesis are cyclical processes that drive all of life's functions.	• In how many different ways can the structure of DNA determine the structure of proteins which carry out the essential functions of life through systems of specialized cells? • How does the hierarchical organization of interacting systems provide specific functions within multicellular organisms? • What are some ways in which feedback mechanisms maintain homeostasis? • What are some ways that cellular division and differentiation can produce and maintain complex living organisms? • What are some reasons why photosynthesis is important for living organisms? • Why are macromolecules essential to life? • What do all cells have in common?

Key Knowledge *As a result of this unit, students will know…*	Key Skills *As a result of this unit, students will be able to…*
• Systems of specialized cells within organisms help them perform the essential functions of life. • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another and release energy to the surrounding environment and to maintain body temperature. • Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles.	• Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells. • Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms • Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. • Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. • Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. • Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

Stage 2: Assessment

Performance Task: Photosynthesis and Cellular Respiration	Other Evidence: *(projects, benchmarks, quizzes, unit tests, multiple choice tests, etc)*

THE INVESTIGATION
 	
OBJECTIVES
In this experiment, students will:
• Use an O_2 Gas Sensor to measure the amount of oxygen gas consumed or produced by a plant during respiration and photosynthesis.
• Use a CO_2 Gas Sensor to measure the amount of carbon dioxide consumed or produced by a plant during respiration and photosynthesis.
• Determine the rate of respiration and photosynthesis of a plant.
	• Assigned readings and reading assignments
	• Class notes
	• Videos/visual aids
	• Lab notebook (for lab work)
	• Other related activities and labs
	  ○ Chemistry of Cells – Synthesis of Macromolecules
	  ○ Comparing Plant and Animal Cells Activity
	  ○ Osmosis in Potatoes
	  ○ Simple Diffusion Using Dialysis
	  ○ Determining the pH of Common Substances Lab
	  ○ Identifying Macromolecules Using Indicators Lab
	  ○ Toothpickase Enzyme Lab Activity
	• Vernier Labs
	  ○ Photosynthesis and Cellular Respiration Lab (using O_2 and CO_2 sensors)
	  ○ Enzyme Action: Testing Catalase Activity (method 1 – O_2 Gas Sensor)
	  ○ Cellular Respiration (using O_2 and CO_2 sensors)

Name of Project:	**Photosynthesis and Cellular Respiration**		**Duration:**	2 weeks (approximate)
Subject/Course:	**Science:** Biology	**Teacher(s):** Secondary Biology Teachers	**Grade Level:**	9 - 12th
Other Subject Areas to Be Included:	• Math – o Model with mathematics. o Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. o Write a function that describes a relationship between two quantities. • English – o Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. o Conduct a short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. o Make strategic use of digital media (i.e. textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.			
Project Idea Summary of the issue, challenge, investigation, scenario, or problem:	• In this experiment, students will use both and O_2 and CO_2 gas sensors to determine the rate of photosynthesis and cellular respiration in a plant. **FOR THIS LAB, ALL STUDENTS ARE REQUIRED TO COMPLETE THE EXTENSION SECTION OF THIS PERFORMANCE TASK.**			
Driving Questions	• How does the hierarchical organization of interacting systems provide specific functions within multicellular organisms? • What are some ways in which feedback mechanisms maintain homeostasis? • What are some reasons why photosynthesis is important for living organisms? • Why are macromolecules essential to life? • What do all cells have in common?			
Next Generation Science Standards to be taught and assessed:	What **Key Knowledge** will students master? What will they know? Enduring Understandings? *Key Knowledge* • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.			

	• Systems of specialized cells within organisms help them perform the essential functions of life. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products • Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. *Enduring Understandings* • The hierarchical organization of interacting systems that provide specific functions within multicellular organisms. • How feedback mechanisms maintain homeostasis. • How photosynthesis transforms light energy into stored chemical energy. • How carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • How cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. What **Key Skills** will students be asked to develop and/or apply? • Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms • Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis • Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.			
21st Century Skills to be taught and assessed**:** *<u>How</u> will they be taught and assessed?*	***Collaboration*** Students will • Work in small groups to design experiments using the scientific method. • Analyze and discuss data obtained during their lab investigation and decide on the best way to process and present their findings.	☒	***Creativity/Innovation*** Students will • Think and work creatively. • Use critical thinking and problem solving skills. • Make judgments and decisions as Individuals and part of a group to effectively analyze and evaluate evidence, major alternative points of view, and interpret and draw conclusions. • Design inquiry-based labs.	☒
	Communication (Oral Presentation) Students will • Learn to present their experimental findings in a clear	☒	***Critical Thinking/Problem Solving*** Students will • Think and work creatively.	☒

	and concise manner and explain their significance.		• Use critical thinking and problem solving skills. • Make judgments and decisions as individuals and as part of a group to effectively analyze and evaluate evidence, analyze and evaluate major alternative points of view, interpret and draw conclusions.	
	Life & Career Students will • Learn to be flexible and adapt to various learning situations (i.e. group settings) • Learn to take Initiative and be self-directed learners by ○ Managing goals and time ○ Working independently and in a group setting.	☒	Other:	☐

Major Products & Performances	Group:	• Students will learn to present their experimental findings in a clear and concise manner and explain their significance. • They will also learn to collaborate in small group setting and learn to be flexible and adapt to various learning situations. • Students will also learn to plan, implement and evaluate experimental findings in a group as well as individually. • Students will also present an evaluation of the lab and procedure.	**Presentation Audience** *(entire project)* **Presentation Audience:** Class School	
			☒	Class – presentation of processed data
			☒	School – students will present their findings to the school during open house.
			☒	Community– students will present their findings to the
		• Students will learn to keep and maintain a laboratory notebook. They will also learn to	☒	Experts – Students may

	Individual:	properly record experimental findings and present them in written form in their lab notebook.	☒	present their findings to other teachers.
			☐	Web – students may choose to share information with other students, schools, and teachers via the web or other electronic media.
			☒	Other: Caltech and CAPSI

LEARNING PLAN: Does it incorporate Authenticity, Choice, Inquiry & students playing the Active Role?

PBL Guiding Principles:

☒ **Authentic,** compelling scenario that matters to student, field, or community
☒ Considers multiple roles/perspectives
☒ Leads to a product for an **authentic** audience
☒ Allows for student **choice**
☒ Point of view/argument that faces opposition
☒ Engaging, high stakes, with a sense of urgency
☒ Transforms or creates content, and opens new questions or cycles of inquiry

What **Performance Assessment Task(s)** will be generated by this project *that is aligned to standards and key skills*:

☒ Math Analysis (Problem Solving) – students will analyze, interpret and process data obtained during the experiment and present it appropriately.
☒ English Textual Analysis – Students will write their own lab reports, which will present their experimental design and findings.
☒ English Research/Argumentation -- students will research their selected topic of investigation.
☒ Scientific Research – Students will evaluate other scientific research and report on the relevance and importance of those findings.
☒ Scientific Inquiry – students will design their own lab investigations.
☒ History/Social Science Research/Inquiry – students will evaluate the impact that scientific research and findings.
☐ Other:

Notes: See attached Stage 2 Task Planning Chart – ENZYME FUNCTION (CATALASE)

L E A R N I N G P L A N

Entry Event to launch inquiry, engage students:		**Benchmark Order**	**Benchmark Category**	**Benchmark Description - what is the assessment?**	**Benchmark Skills – what will this help them to be able to do?** *If a benchmark asks them to report on what they have researched, then they will be able to complete independent research, summarize information, synthesize information, etc.*
Assessments *Under each type of assessment, there are ideas as to some you might use. These lists are not exhaustive. You may choose to include others not listed.* *The number of benchmarks may be more or less than the number listed. Feel free to document the amount that you will use. If you need more, you may use another sheet.*	**Formative Assessments** (During Project) i.e., *Quizzes/Tests, Journal/Learning Log, Preliminary Plans/Outlines/Prototypes, Rough Drafts, Practice Presentations, Notes, Checklists, Concept Maps*	**Benchmark 1:**	☒Know (mastery) ☐Do (application) ☐Reflect (metacognition)	Cellular structure – Animal Cells vs. Plant Cells	Students will compare and contrast animal vs. plant cells
		Benchmark 2 :	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Activity: Cellular Organelles and Functions	Students will be able to identify and recall the function of the various organelles in both plants and animal cells. Students will then create models of the different organelles, arrange, and organize them to create a cell.
		Benchmark 3:	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Components of Light and Electromagnetic Spectrum	Students separate light using a prism.
		Benchmark 4:	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Stages of Photosynthesis	Students will be able to model/simulate the stages of photosynthesis including the reactants and products at each stage.
		Benchmark 5:	☒Know (mastery) ☒Do (application) ☐Reflect (metacognition)	Photosynthesis vs. Cellular Respiration	Students will compare and contrast the processes of cellular respiration and photosynthesis.

	Summative Assessments (End of Project) i.e., *Written Product(s) with rubric, Oral Presentation with rubric, Multiple Choice/Short Answer Test, Essay Test, Other Product(s) or Performance(s) with Rubric, Self-Evaluation, Peer Evaluation*	**Benchmark 6:**	☒ Know (mastery) ☒ Do (application) ☐ Reflect (metacognition)	Photosynthesis and Cellular Respirations	In this experiment, you will use both and O_2 and CO2 Gas Sensors to determine the rate of photosynthesis and cellular respiration in a plant. They will then evaluate and determine how and to what extent. changing various environmental factors affects the rates of both cellular respiration and photosynthesis
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		

PART B:

Project Launch – Start with a Bang!

Launch Guiding Principles:

- ☒ High interest, provocative, communicates a sense of urgency
- ☒ Provides overview of project without going into too much detail
- ☒ Provides models/examples of culminating products
- ☒ Provides timeline with major benchmarks
- ☒ Motivating - urges students to explore what is possible within the project
- ☒ Presents an exciting challenge that also feels attainable, students can imagine themselves accomplishing the project
- ☒ Addresses the question of "So what…?"

What venue will you use to launch this project (community meeting, multiple classes, within your class, field trip, etc.)?	Who will be involved in the launch (multiple teachers, just you)?	When will you launch this project?
Launch Agenda: In-class Have students identify different forms of energy	Staff Roles: Teacher – Facilitator Students – Participants	January 2014-June 2014

Action Steps/Follow Up after the launch:

REVIEW – Cellular Structure and Functions: Plants vs. Animal Cells

- How do different organisms harvest and use energy?
  - Electromagnetic spectrum
- Energy in colors – Why do some plants absorb some colors of light better than others?

Resources Needed	**On-site people, facilities:**	• Teacher, TA (to help students with set up or other related questions), lab classroom with internet access and electric outlets. Access to an open space with plenty of sunlight.
	Equipment:	• Computers (laptops), Vernier software and Interface, O_2 and CO2 probe, BioChanmber 250 (preferably the one with two openings for probes).
	Materials:	• Plant leaves (spinach or parsley), 500mL tissue culture flask, lamp (and different colored light bulbs), aluminum foil, forceps, paper towels.
	Community resources:	• CAPSI/Caltech • Oak Crest Institute of Science • Amgen-Bruce Wallace • Pasadena City College (PCC)

Reflection Methods	**(Individual, Group, and/or Whole Class)**	**Journal/Learning Log** • *Individual* ○ Students will write in their lab notebook. Students are responsible for maintaining their notebook. • *Group* ○ Students will record data and observation as it pertains to their experiments. They will also write/record their conclusions and evaluations at the end of each experiment.	☒	Focus Group	☐
		Whole-Class Discussion • *Individual/Group* ○ As part of the lesson, students will be presented with information as it pertains to the lesson and the experiment they might conduct. • *Group* ○ Students can present their findings to the class.	☒	Fishbowl Discussion	☐
		Survey	☐	Other:	☐